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Attachment and physiological reactivity to infant crying in young adulthood: Dissociation between experiential and physiological arousal in insecure adoptees

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HIGHLIGHTS

- Variation in attachment is associated with differences in arousal to infant crying.
- In secure adoptees experiential arousal and physiological arousal to infant crying are integrated.
- In insecure adoptees experiential arousal and physiological arousal to infant crying are dissociated.
- Insecure adoptees use a deactivating style in response to infant crying.

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ABSTRACT

The associations between attachment representations of adopted young adults and their experiential and physiological arousal to infant crying were examined. Attachment representations were assessed with the Attachment Script Assessment (ASA), and the young adults listened to infant cries, during which ratings of cry perception were collected and physiological reactivity was measured. Secure adoptees showed a well-integrated response to infant distress: heart-rate increases and respiratory sinus arrhythmia (RSA) withdrawal were coupled with heightened perception of urgency in these individuals. In insecure adoptees RSA withdrawal was absent, and a combination of lowered perceived urgency and heightened sympathetic arousal was found, reflecting a deactivating style of emotional reactivity. Overall, our findings support the idea that internal working models of attachment explain individual differences in the way attachment-related information is processed.

1. Introduction

Central to attachment is children's need for adult support when they struggle with negative feelings. Whereas parental support – e.g., comfort in case of distress – is expected to contribute to secure child attachment and emotional self-regulation, the lack of such support may reduce children's sense of security and may increase the risk of less effective emotion regulation [11]. Based on their experiences with caregivers in (early) childhood and adolescence, individuals develop emotion regulation patterns that are shaped by the security of the relationship with their main attachment figures to cope with stressful situations without becoming too overwhelmed by negative emotions [8,19]. In recent studies, physiological measures have been used to index emotional responding and regulation, potentially broadening our understanding of variation in emotional reactivity as a function of attachment security (e.g., [1,27,48]). In the present study we tested whether young adults' attachment representations, as measured with secure base scripts in the Attachment Script Assessment (ASA; [70], also known in the literature as Secure Base Script), were related to their experiential and physiological arousal to emotional stimuli.

The ASA [70] is a cost-effective alternative to the gold standard of adult attachment assessment, the Berkeley Adult Attachment Interview (AAI; [25,31,44]). The concept of a secure base script is derived from attachment theory [67] and makes use of insights from cognitive science, in particular research on mental models. Similar to the idea of internal working models [8], a secure base script is considered a mental representation that is formed based on an individual's history of secure base support [68]. Consistent and coherent support leads to a script that is easily accessible and includes the idea that the primary caregiver will be there for support, especially in times of need. Inconsistent or

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ineffective support leads to a script that is incomplete and less accessible or includes more negative expectations about significant others [70].

1.1. Attachment and emotional reactivity

Individual variation in young adults' attachment representations as reflected in different styles of emotional responding should become clearest when young adults are confronted with attachment-related stressors [26,40]. Infant crying is such a stressor; infant cries evoke physiological arousal in adults, both males and females, and parents and non-parents [24,27]. Infant cry sounds provide information about the infant's health and level of distress [28,47], and are produced to elicit caregiving responses [8,47,71]. For example, high-pitched cry sounds are indicative of higher levels of infant distress [74], and adults are likely to perceive these signals as more urgent and in need of more prompt caregiving behaviors than low-pitched cries [49]. There is also evidence that adults become increasingly sensitized to repeated infant distress signals (e.g., [49]). Repeated exposure to cry sounds is therefore considered as more stressful and tends to evoke heightened physiological arousal. Our study design was based on the study by Out et al. [49] using the same cry paradigm, which showed significant differences in responses across blocks instead of between frequencies.

According to Dykas & Cassidy [19], individuals process social information in a way that is congruent with their attachment-related experiences: secure individuals process it in a positively biased manner, whereas insecure individuals process it in a negatively biased manner. Congruent with their early negative experiences, insecure individuals can become emotionally stressed while processing negative attachment-related social information, leading to a hyperactivating response [17]. However, if the information is attachment related and emotional components of the information are likely to cause psychological distress, insecure individuals might use an emotional response style characterized by defensive exclusion of the information from further processing, also known as a deactivating style [9,19]. Thus, dependent on the type of attachment-related information received (non-threatening versus threatening), insecure individuals will either process information using a strategy marked by hyperactivation or marked by deactivation [40].

Several studies have shown links between an adult's AAI classification as insecure, either dismissing or preoccupied, and physiological reactivity to attachment-related stressors. Deactivating strategies during the AAI were associated with heightened skin conductance levels (SCLs) in reaction to negative attachment stimuli [1,18,34,55,56], whereas hyperactivation strategies were associated with increases in heart rate [55]. Using the ASA to assess attachment, Groh and Roisman [27] found that low scores on the ASA were uniquely linked to heightened electrodermal reactivity (SCL) in individuals listening to infant crying.

Besides electrodermal activity as a measure of sympathetic activity, parasympathetic activity (respiratory sinus arrhythmia; RSA) and its link with attachment are relevant. It has been suggested that secure individuals show clearer signs of parasympathetic withdrawal or vagal tone (in combination with indices of mild sympathetic responses) when confronted with attachment-related stressors, which might be an indicator of more adequate responding to external stressors in these individuals compared to insecure individuals [37,51]. However, a replicable pattern of associations between quality of attachment and parasympathetic activity has not been established yet [17,32,48,55].

1.2. The present study

In our study we tested whether attachment representations were associated with experiential arousal and both sympathetic and parasympathetic reactivity to infant cries in adopted young adults. We examined both reactions to the stressor and recovery, as previous studies revealed that differences in attachment styles may predict the extent to which levels of physiological arousal return to baseline levels after exposure to the stressor (e.g., [53]).

Attachment relationships in adoptees are of special interest, because these individuals experienced separation from or loss of their birth parents, which may negatively affect subsequent relationships with primary caregivers [8]. In addition, exposure to early adversities, such as institutional care, maltreatment, and neglect, may have negative long-term consequences for social and emotional development [41], or more specifically may increase the risk for insecure attachment in these children (for a meta-analysis see [63]). We examined the adoptees' working models of attachment in young adulthood, after they were raised by their genetically unrelated adoptive parents. As a consequence, possible associations are not confounded by genetic influences that play a role in the transmission of attachment and emotional reactivity across generations [30,46]. On the other hand, it might be possible that within the individual adoptee, the same set of genes contributes to both attachment security and responding to infant crying. A recent twin study indicated that genetic relatedness may play a role in explaining individual differences in attachment beyond childhood [21], and a twin design also showed that there is a substantial genetic component of adults' physiological reactivity to infant cry sounds [49].

Based on the positive experiences with their attachment figures, secure adoptees were expected to show optimal emotional reactivity [8,35], processing the attachment-related information in a relatively open manner [19]. That is, we expected them to show parasympathetic withdrawal during exposure to the cries, and convergence between experiential and physiological arousal, with both experiential and physiological arousal being higher during exposure to the cries versus baseline and recovery, and higher in later versus previous blocks of cry sounds due to repeated exposure [49]. Insecure adoptees were expected to display less optimal emotional reactivity, characterized by either a hyperactivating or a deactivating strategy [40]. In case of hyperactivation, individuals will display both heightened experiential and physiological arousal in reaction to the infant cries. In case of deactivation, exclusion of the attachment-related information from further processing will result in heightened physiological arousal in the absence of heightened experiential arousal [16], or flattened experiential *and* physiological arousal to the infant cries, dependent on how complete the exclusion of information is [9].

2. Method

2.1. Participants

In the Leiden Longitudinal Adoption Study 190 internationally adopted children (100 girls) were followed from infancy to the age of 23 years (for details on earlier phases of the study, see [4,36,61]). The children arrived in the Netherlands before the age of six months ($M = 10.28$ weeks, $SD = 5.42$) and were adopted from Sri Lanka ($n = 116$), South Korea ($n = 49$), and Colombia ($n = 25$). The adoptive families were recruited in a non-selective way through Dutch adoption organizations. Children's placement in adoptive families was based solely on the parents' position on the waiting list of the adoption agency, and not on characteristics of the parents or children. All parents were Caucasian and came from predominantly middle-class socio-economic backgrounds.

The original sample consisted of 160 families in infancy. At 7 years, 30 adoptive families from the same population were added to the sample. Compared to the original infancy sample no differences in background variables were found. Of these 190 adoptive families, 166 provided measures of sensitivity in middle childhood (13% attrition), and 152 participated in adolescence (20% attrition). At the current assessment at 23 years, 117 adoptees participated in the study. Long traveling distances, lack of interest, or time constraints were the major reasons for nonparticipation.

2.2. Procedure

In infancy, home visits took place at 5, 6, 9, and 12 months, and mother and child came to the laboratory at 12, 18, and 30 months. During the home visits 50 randomly selected families received a short-term intervention to promote maternal sensitivity [39]. In the follow-up assessments at 7, 14, and 23 years, four major domains of development were investigated: social development, personality development, cognitive development, and behavioral adjustment. The current study used physiological measurements to examine social–emotional functioning at age 23. At this age, the adoptees came to the laboratory and attachment representations were assessed. In the same laboratory visit, they also completed a computer task with a cry paradigm. During this task, ratings of cry perception were collected, the electrocardiogram (ECG) and thoracic impedance (to obtain a breathing signal) were recorded, and the level of skin conductance was measured. The young adults also completed an intelligence test. Throughout the study, ethical guidelines of the research institute were followed. Prior to the follow-up study at age 23 (ethical review board protocol number ECPW-2010/019), informed consent was obtained from all participants. The informed consent form contained information about both participation in the study in general and the specific elements of the laboratory visit such as the heart rate measurement.

2.3. Measures

2.3.1. Attachment representations

The Attachment Script Assessment (ASA; [70]) was conducted in young adulthood to assess attachment representations. Participants received four prompt word outlines that were developed to evoke the production of attachment-related stories. Both mother/child stories and adult/adult stories were included. Participants were instructed to use the twelve provided words to frame their best possible story, and they were prompted to elaborate on the story. Stories were audiotaped and literally transcribed. Transcripts were scored based on the presence or absence of a prototypic secure base script; this script suggests that there is a secure base in the story (parent or partner) who helps the main character deal with distress and helps things get back to normal [70]. Stories were coded on a 7-point scale (higher scores indicating more secure attachment) by three coders who were blind to all background information and to the other stories told by the same participant. An expert coder coded 100% of the stories and two other coders each coded 50% of the stories. Intercoder reliability at two stages of the scoring process (at the start and at the end) ranged between .78 and .88 (intraclass correlations, single measure, absolute agreement). In case of discrepancy between scores of the expert coder and the other coders, that is, a difference of two or more points between scores (in 1.4% of the cases), the expert coder decided on the final score. Average scores for the pairs of coders were used and integrated into one composite attachment security score for each of the participants, based on the mean scores of all four ASA stories.

Reliability and validity of the ASA measure have been tested in various cross-national studies [7,12,20,64,65]; see Bakermans-Kranenburg [2] for a summary of the findings.

Continuous attachment security scores were used in the main analyses, but to further elucidate significant effects we included secure versus insecure categories in additional (follow-up) analyses to get more insight into differences in reactivity between adoptees in which the secure base script was absent versus present. According to the ASA scale [69], stories with scores below 3 contain negative or insecure elements, for example brief, disjointed or inconsistent stories, whereas positive or secure elements are found in stories coded 4 or higher. Cut-offs of 3 and 3.75 were used based on recommendations by H. Waters for categorization of ASA scores into three groups, who considers the secure base script to be present when scores are higher than 3.75. We distinguished participants labeled as insecure ($n = 18$) from those showing some security ($n = 48$), and those labeled as secure ($n = 51$), respectively. For the additional analyses, we focused on the insecure versus the secure group ($N = 69$).

2.3.2. Cry paradigm

Following a 4-min baseline of neutral images (landscape photographs), three blocks with each three cry sounds were presented through Sennheiser HD202 headphones at a constant volume. Within blocks, cries of 500, 700, and 900 Hz were presented in a random order. In between baseline and the first block of sounds, participants practiced with the cry of 500 Hz to get used to the format of the task. Exposure to cry sounds was followed by a 4-min recovery of neutral images (landscape photographs). Stimulus presentation was controlled by E-prime 2.0 software (Psychology Software Tools, Inc.).

Cry stimuli were obtained by recording the spontaneous crying of a healthy, 2-day-old, normal birth weight, and full-term baby girl, of which a 10-s period was selected. The seven cry expirations within sounds had a mean duration of 1055 ms (range, 545 to 1899 ms) and a mean fundamental frequency peak F0 of 452.6 Hz (range, 425.2 to 515.6 Hz; 500 Hz cry). To provide cry stimuli with a wide range of fundamental frequencies, the original cry (averaging approximately 500 Hz) was digitally altered to increase the fundamental frequency while holding temporal and other spectral aspects of the cry constant. Two new 10-s cry stimuli were created by digitally increasing the original cry by approximately 200 and 400 Hz, respectively, resulting in two new cry sounds with an overall peak of $F0 = 714.5$ Hz (700 Hz cry) and $F0 = 895.8$ Hz (900 Hz cry). Digitally manipulated cry sounds have been successfully used in previous studies, showing their validity in terms of perception and (anticipated) caregiving responses [15,37,57,58]. The acoustic and temporal structure of the original cry sound is characteristic of the cries of normal, healthy infants (e.g., [42,66]). Fundamental frequencies of 700 and 900 Hz (and even higher) are observed in transient pain cries of healthy infants and in infants being separated from their parents [52,72], as well as in cries of infants with medical and neurological conditions [59].

The presentation of each stimulus was followed by a rating of the participant's perception of the characteristics of the cry on four rating scales with a 5-point scale: not aroused–aroused, not urgent–urgent, healthy–sick, and not aversive–aversive [73]. Following Out et al. [49], who found one component underlying these ratings, we used one composite urgency score of the four questions for each block of cry sounds. Cronbach's alphas (calculated across the four questions within each of the blocks) ranged from .70 to .76. The cry stimuli as well as the design of this particular paradigm have been used with different samples in previous studies on physiological reactivity to infant crying [37,49,54].

2.3.3. Inter-beat interval (IBI), skin conductance level (SCL), and respiratory sinus arrhythmia (RSA)

The Ambulatory Monitoring System (VU-AMS5fs, TD-FPP, Vrije Universiteit, Amsterdam, the Netherlands; [14]) was used to measure the electrocardiogram (ECG), thoracic impedance, and level of skin conductance during the cry paradigm (see [4,6] for earlier findings on the use of the VU-AMS device in our sample of adoptees). For the ECG, three disposable pre-gelled Ag–AgCl electrodes (ConMed, New York, USA) were placed below the right collar bone 4 cm to the right of the sternum, 4 cm under the left nipple, and at the lateral right side. For the impedance cardiogram (ICG), four electrodes were attached at the top end of the sternum between the tips of the collarbones, on the spine, at the low end of the sternum where the ribs meet, and again on the spine (at least 3 cm below the previous one). To measure skin conductance, two small Ag–AgCl electrodes, filled with isotonic GEL101 electrode paste, were placed on the middle and index fingers of the adoptee's non-dominant hand.

VU-DAMS software packages derived inter-beat interval time series (IBIs) by automatic peak detection of the R-wave. We inspected each ECG recording and corrected it manually when necessary. The software automatically marked inspirations and expirations from the thoracic impedance signals, and derived average IBI and SCL per segment, i.e., the 4-min baseline, nine 15-s intervals time-locked to the onset of each cry sound (thus, these epochs consisted of a 10-s cry sound and an additional 5 s in which participants completed the perception ratings), and the 4-min recovery period. RSA was calculated per breathing cycle as the difference between the longest IBI during expiration and the shortest IBI during inspiration and averaged across each labeled period. RSA values for breaths with an invalid RSA (i.e., artifacts; irregularities in respiration and heart rate) were set to zero. Respiration rate and tidal volume were taken into account in analyses on RSA, as RSA is known to be susceptible to changes in breathing pattern (e.g., [5,33]). Technical problems led to missing data on IBI, SCL, RSA, respiration rate, and tidal volume for three participants. In addition, RSA, respiration rate, and tidal volume could not be calculated during the blocks of cry sounds for one more participant due to the presence of too many artifacts. Values for IBI, SCL, RSA, respiration rate, and tidal volume were averaged across the three cry sounds in each block (i.e., average of three consecutive episodes of 15 s, resulting in a total of 45 s), for baseline and recovery an average value was calculated for the 4-min period. Change scores were created for each of the three blocks and the recovery, by subtracting baseline values from those obtained during the other episodes.

2.3.4. IQ at 23 years

To enable controlling for differences in IQ–related verbal fluency, intelligence of the participants was measured with a revised version of the Groningen Intelligence Test (GIT 2; [43]). Test–retest reliability was above .80 for all subtests. A correlation of $r = .54$ was found between GIT 2 IQ scores and educational level [43]. The abbreviated version used in this study consisted of five subtests: Vocabulary, Matrices, Puzzles, Figures, and Numeracy. Scores for the first two subtests were summed ($r = .39$, $p < .01$) and transformed into a verbal IQ score.

2.4. Statistical analyses

A repeated measures ANOVA was conducted to examine the associations between attachment security and perceived urgency of the cry sounds, with perceived urgency as outcome measure, three blocks of cry sounds as within-subjects factor, and attachment security as between-subjects factor (numerical variable).

For physiological reactivity (IBI, SCL, and RSA), we checked associations between baseline values and attachment security. We correlated change scores with baseline values for each physiological measure and, if needed, controlled for the baseline in the subsequent analyses. To examine the relation between attachment security and physiological reactivity to the cry sounds, repeated measure ANOVAs were performed with IBI, SCL and RSA change scores as outcome measures, episode (three blocks of cry sounds and recovery) as within-subjects factor, and attachment security as between-subjects factor. Greenhouse–Geisser epsilon was used to correct for violation of sphericity when necessary.

In both the analyses on experiential and physiological reactivity gender was taken into account by adding this variable as a between-subject factor. Similar to the approach of a previous study on SCL in these adoptees in adolescence [4], we specifically checked whether SCL reactivity was associated with country of origin of the adoptees. Two dummy variables of country of origin were constructed and added as between-subjects factors in the repeated measure ANOVA.

Because RSA can be influenced by respiration rate and tidal volume (e.g., [5,33]), additional analyses were performed with change scores of respiration rate and tidal volume as outcome measures, episode as within-subjects factor (three blocks of cry sounds and recovery), and attachment security as between-subjects factor. In case of significant main or interaction effects, respiration rate and tidal volume were controlled for in the analyses on RSA reactivity by adding one of these factors as a second within-subject factor.

3. Results

3.1. Preliminary analyses

Table 1 presents the descriptives of the original physiological variables for the two groups of attachment security (secure versus insecure). The correlations among the original scores of the physiological measures in all episodes of the cry paradigm are shown in Table 2. Significant correlations were found for different episodes using the same physiological measure and between measures of IBI and RSA, independent of episode. The original physiological scores were transformed into change scores, and we checked standardized kurtosis and skewness per episode for IBI, SCL and RSA. Variables with standardized skewness or kurtosis outside the normal range (numerical values more than three times larger than their standard error) included the first episode of IBI, all episodes of SCL, the last three episodes of RSA, and all episodes of tidal volume. These variables were winsorized preserving the original order [62].

No associations were found between attachment security and major background variables such as country of origin, experimental condition of the short-term intervention in infancy, socio-economic status of the adoptive parents, age on arrival and age at testing in young adulthood (p ranged between .21 and .73). Also, verbal IQ of the adoptee was not associated with attachment security ($p = .48$). The only exception was gender: girls showed higher attachment security than boys, $t(115) = -2.02$, $p = .05$, $d = -0.37$.

3.2. Perceived urgency

Inclusion of gender in the analysis did not change the significance of the effects; therefore outcomes of the original (uncorrected) analyses are presented here. No main effects of blocks or interaction between blocks and attachment security were found ($ps > .19$), but a main effect of attachment security did appear, $F(1, 113) = 5.81$, $p = .02$, partial $\eta^2 = .05$. Additional analyses were performed with the two groups of attachment security to further explore this main effect. Outcomes indicated that secure adoptees reported significantly higher mean overall urgency in response to the cry sounds than insecure adoptees (see Fig. 1).

Table 1
Descriptive statistics of two groups of attachment security.

		Secure			Insecure		
		M	*SD*	*n*	*M*	*SD*	*n*
Urgency	Block 1	2.52	.64	51	2.32	.72	18
	Block 2	2.68	.73	51	2.23	.79	18
	Block 3	2.73	.66	51	2.23	.87	18
IBI	Baseline	841.83	112.06	48	829.84	131.24	18
	Block 1	850.06	108.56	48	846.56	126.42	18
	Block 2	839.99	110.38	48	831.10	117.49	18
	Block 3	828.74	111.17	48	811.94	119.84	18
	Recovery	827.43	109.26	48	809.88	124.57	18
SCL	Baseline	5.58	3.60	48	5.98	4.29	18
	Block 1	6.22	3.95	48	6.67	4.66	18
	Block 2	6.26	3.88	48	6.90	4.69	18
	Block 3	6.29	3.81	48	7.10	5.06	18
	Recovery	6.23	3.76	48	7.43	5.01	18
RSA	Baseline	77.04	35.66	48	64.50	24.96	18
	Block 1	68.38	39.14	47	63.48	38.02	18
	Block 2	68.36	38.34	47	72.33	34.99	18
	Block 3	63.92	33.45	47	73.76	45.55	18
	Recovery	70.91	33.93	48	63.73	24.49	18

Note. Based on scores before transformation and winsorizing.

Table 2
Correlations among physiological measures.

	IBI.b	IBI.1	IBI.2	IBI.3	IBI.r	SCL.b	SCL.1	SCL.2	SCL.3	SCL.r	RSA.b	RSA.1	RSA.2	RSA.3	RSA.r
IBI.b	–														
IBI.1	.94**	–													
IBI.2	.93**	.95**	–												
IBI.3	.93**	.94**	.96**	–											
IBI.r	.96**	.94**	.93**	.94**	–										
SCL.b	−.14	−.08	−.10	−.08	−.07	–									
SCL.1	−.16	−.10	−.13	−.10	−.09	.99**	–								
SCL.2	−.17	−.10	−.13	−.10	−.10	.98**	.99**	–							
SCL.3	−.15	−.08	−.12	−.09	−.09	.96**	.98**	.99**	–						
SCL.r	−.15	−.08	−.12	−.09	−.09	.95**	.97**	.99**	.99**	–					
RSA.b	.43**	.38**	.40**	.36**	.37**	−.14	−.15	−.15	−.15	−.16	–				
RSA.1	.30*	.35**	.37**	.38**	.29*	−.10	−.11	−.10	−.10	−.10	.72**	–			
RSA.2	.39**	.42**	.41**	.38**	.37**	−.08	−.10	−.09	−.08	−.08	.77**	.67**	–		
RSA.3	.32**	.33**	.34**	.34**	.30*	−.12	−.12	−.11	−.10	−.10	.65**	.66**	.74**	–	
RSA.r	.45**	.42**	.44**	.45**	.46**	−.09	−.10	−.10	−.10	−.10	.85**	.78**	.80**	.73**	–

Note. Based on scores before transformation and winsorizing; b = baseline, 1 = block 1, 2 = block 2, 3 = block 3, r = recovery; *N* ranges between 64 and 66.
* $p < .05$.
** $p < .01$.

3.3. Physiological reactivity

Baseline values of IBI, SCL and RSA were not associated with attachment security (*ps* > .06). Change scores (cry sound/recovery minus baseline) were significantly correlated with baseline values for all outcome measures. Therefore, we also conducted the analyses with baseline entered as a covariate. All main effects and interaction effects remained significant after inclusion of the baseline values. In the analyses on physiological reactivity with gender added as a between-subjects factor, no significant main effects of gender were found (*ps* > .32), and all main and interaction effects remained significant. One exception was the interaction effect (between episode and attachment security) in the analysis with SCL as outcome measure, but the change in explained variance was smaller than 5%. Therefore, we did not control for gender in the reported analyses and stuck to the original analyses in this section.

3.3.1. Inter-beat interval (IBI)

A (within-subjects) main effect of episode on IBI was found, $F(3, 108) = 5.46$, $p < .01$, partial $\eta^2 = .05$. IBI values significantly decreased from block 1 ($M = 12.61$, $SD = 36.21$) to block 3 ($M = -15.40$, $SD = 42.02$), $p < .01$. Neither a significant main effect of attachment security nor an interaction effect between episode and attachment security was present (*ps* > .27). Fig. 2 shows the parallel lines for IBI reactivity in the secure versus insecure group, resulting from the analysis in which the categorical distribution of attachment was taken into account.

3.3.2. Skin conductance level (SCL)

In the analysis with SCL as an outcome measure, the dummy variables of country of origin were added as between-subjects factors. Main effects of both dummy variables were absent (*ps* > .06), and inclusion of the dummies did not lead to change in significance of the effects. Therefore the outcomes of the original (uncorrected) analyses are reported here. A main effect of episode appeared, $F(1.74, 108) = 5.55$, $p < .01$, partial $\eta^2 = .05$ (Greenhouse–Geisser correction for sphericity). Although a main effect of attachment security was absent ($p = .55$), a significant interaction between episode and attachment security was found, $F(1.74, 108) = 3.85$, $p = .03$, partial $\eta^2 = .03$ (Greenhouse–Geisser correction for sphericity). Contrast analyses showed a significant difference for the contrast from blocks (1, 2, 3) to recovery, $F(1, 108) = 8.71$, $p < .01$, partial $\eta^2 = .08$. The additional analysis revealed that SCL values remained stable from block 3 ($M = .68$,

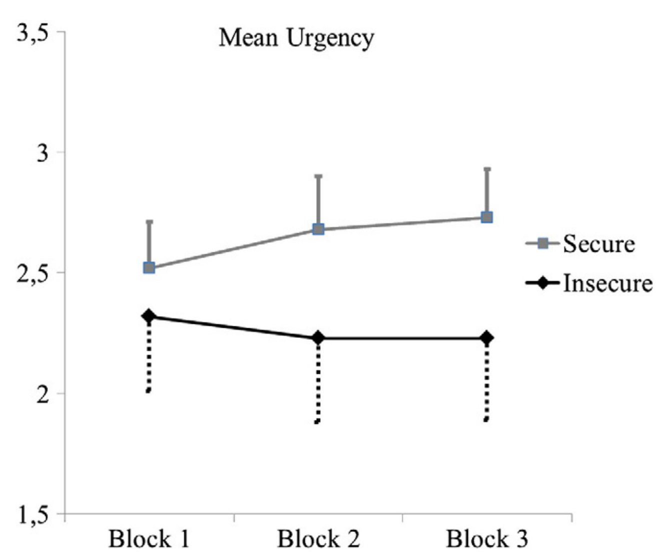

Fig. 1. Perceived urgency of cry sounds (*M*, *SE*) across blocks for two groups of attachment security.

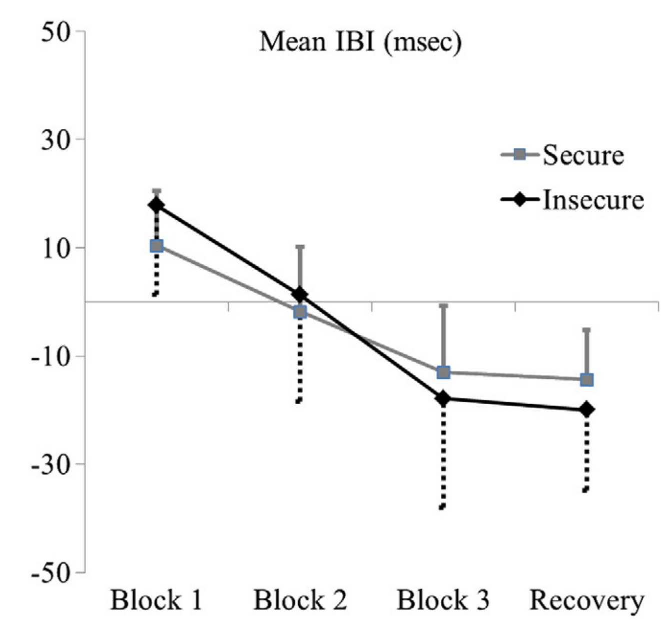

Fig. 2. Inter-beat interval (*M*, *SE*) across episodes for two groups of attachment security.

$SD = .90$) to recovery ($M = .63$, $SD = .91$) in the secure group, whereas SCL values increased from block 3 ($M = .63$, $SD = .91$) to recovery ($M = 1.25$, $SD = 1.25$) in the insecure group (see Fig. 3).

3.3.3. Respiratory sinus arrhythmia (RSA)

First, we conducted analyses with respiration rate and tidal volume to test whether the RSA outcomes were a result of changes in breathing pattern. In the repeated measures ANOVA with respiration rate as outcome measure, a main effect of attachment security was found, $F(1, 106) = 7.17$, $p < .01$, partial $\eta^2 = .06$. Respiration rate was included as a second within-subject factor in the analysis on RSA reactivity, but did not change the significance of the effects on RSA. In the repeated measures ANOVA with tidal volume as an outcome measure, significant effects (main effects of episode and attachment, and the interaction effect between both factors) were absent ($ps > .68$), and consequently no further analyses were performed.

Returning to the original analysis with RSA as the only included outcome measure, a significant main effect of attachment was found, $F(1, 104) = 5.49$, $p = .02$, partial $\eta^2 = .05$. The main effect of episode and the interaction effect between episode and attachment security did not reach significance ($ps > .29$). According to the additional analyses, the main effect of attachment security could be interpreted as secure adoptees showing lower mean overall RSA levels than the insecure adoptees (see Fig. 4). Though this extra findings must be considered as exploratory, differential patterns of RSA responding seemed to be present in the final stage of the paradigm for secure versus insecure adoptees. Secure adoptees showed increased RSA values from block 3 ($M = -14.02$, $SD = 3.56$) to recovery ($M = -5.26$, $SD = 2.18$), whereas insecure adoptees showed decreased RSA values from block 3 ($M = 4.52$, $SD = 5.92$) to recovery ($M = .59$, $SD = 3.62$).

4. Discussion

In the present study we tested whether attachment representations, as measured with the Attachment Script Assessment (ASA), were related to experiential and physiological arousal to infant cries in adopted young adults. Insecure adoptees differed significantly from secure adoptees in their ratings of urgency in all episodes of the cry paradigm; they reported lower urgency than the secure adoptees. Secure and insecure adoptees did not significantly differ on IBI, but main effects of attachment security and/or interaction effects between episode and attachment security appeared for SCL and RSA. Secure adoptees showed SCL values that remained stable from the most stressful episode of the cry paradigm to recovery, whereas insecure adoptees showed an increase in SCL. Differences in vagal tone were also found, with secure adoptees showing significantly lower RSA values than insecure adoptees. Our findings suggest that secure adoptees have a well-integrated manner of responding to infant distress (i.e., heart-rate increases and RSA withdrawal coupled with heightened perceptions of urgency), whereas a dissociation between experiential and physiological arousal is found in insecure adoptees, who displayed a combination of lower perceived urgency and heightened sympathetic reactivity and heart rate, without RSA withdrawal.

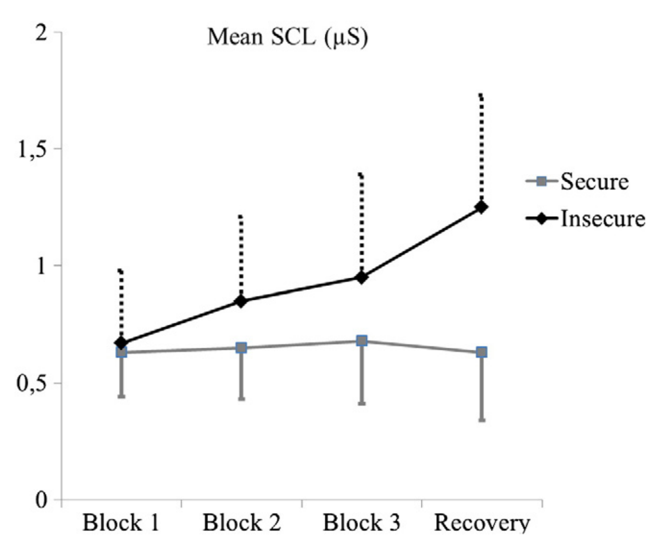

Fig. 3. Skin conductance level (*M*, *SE*) across episodes for two groups of attachment security.

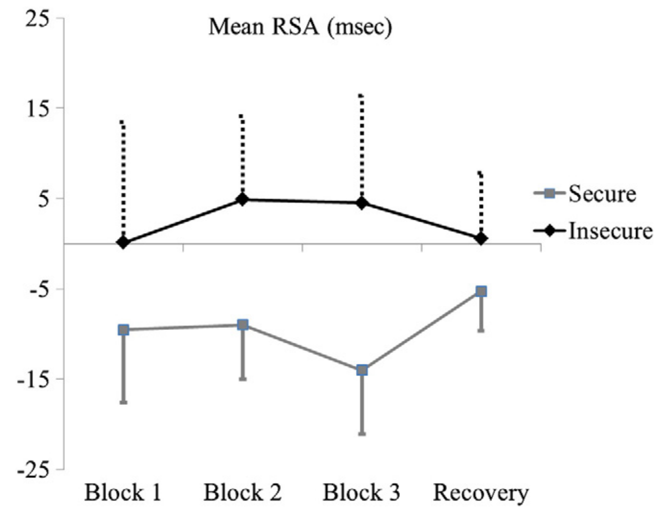

Fig. 4. Respiratory sinus arrhythmia (*M*, *SE*) across episodes for two groups of attachment security.

In support of our hypothesis, we found attachment representations assessed with the ASA to be associated with emotional reactivity during exposure to and recovery from an attachment-related stressor. In line with previous research on the ASA [27], attachment security was associated with electrodermal reactivity (SCL) after exposure to an attachment-related stressor, and associations with IBI were absent. The pattern of heightened electrodermal reactivity during the recovery period found in individuals with lower ASA scores can be seen as indicative of heightened sympathetic arousal ([13], p. 210), which have been suggested to lead to more inhibition and possibly less affective responses to infant distress [22,23] or more difficulties returning to calm emotional and behavioral states.

Our outcomes also provided evidence for parasympathetic differences between secure and insecure adoptees: RSA values were significantly lower in secure adoptees than in insecure adoptees. The secure adoptees showed a pattern of RSA withdrawal when confronted with an attachment-related stressor, which has been linked to more adequate responding to infant distress [50,51]. Our RSA outcomes are in line with the findings of Dias et al. [17], who studied associations between attachment security and physiological reactivity during the AAI. They found some evidence for parasympathetic withdrawal in women with relatively secure AAI classifications. Also, Ablow et al. [1], who included simple and complex cry stimuli as an attachment-related stressor, found that RSA decreases in reaction to the cry stimuli were absent in insecure-dismissing women, a pattern of responding that is generally not indicative of efforts to soothe the infant [3,29].

The dissociation between experiential and sympathetic arousal found in insecure adoptees suggests that these individuals use a deactivating style of emotional reactivity while processing attachment-related information [16]. The lack of RSA withdrawal in insecure individuals (in fact, average reactivity values were positive) is consistent with this deactivating style, as attempts to suppress negative emotions or arousal have been related to increases in RSA (e.g., [10]). According to Dykas & Cassidy [19], the presence of a deactivating strategy in persons with insecure attachment representations might indicate that these individuals experience psychological distress while listening to the infant cry sounds, which prevents them from further adequately processing of the information. A negative consequence of being insecure and not recognizing one's own physiological arousal might be that it also prevents individuals from developing more adaptive styles of emotional reactivity in the future [16].

Some limitations of our study should be addressed. For the attachment categorization, we used cut-off scores to select participants who clearly showed secure versus insecure attachment representations. It should be noted that differentiation of the different subtypes of insecure (dismissing and preoccupied) attachment representations based on the ASA needs further research. Besides, we had no data on physical exercise in the week prior to the assessment, smoking on the morning of the lab session and possible use of medication influencing heart rate. We would have preferred to use these variables as covariates in the analyses on physiological reactivity, although in past studies such covariates did not explain much of the variance in physiological reactivity and it is not evident that they might have influenced the differences found in physiological reactivity between the two groups (e.g., [37]). Furthermore, the assessment of attachment representations did not temporally precede the assessment of reactivity to infant crying, and therefore no causal inferences could be drawn from our study on concurrent data.

In sum, we examined whether attachment representations were related to experiential arousal and physiological reactivity to infant cries in adopted young adults. The use of a standard cry paradigm enabled us to investigate reactions to stimuli representing increasing levels of distress as well as (in–)congruence between experiential and physiological arousal. We found some empirical support for the hypothesis that internal working models of attachment, presumably based on the experiences with primary caregivers, explain individual differences in the way attachment-related information is being processed [8,19]. Due to the inclusion of adoptees associations were not confounded by genetic influences that play a role in the transmission across generations, although the same set of genes in the adoptee may have contributed to both attachment security and responding to infant crying. In addition, the concurrent associations found between young adults' attachment representations and their experiential and physiological arousal to infant distress add to the criterion validity of the ASA.

Our findings suggest that secure adoptees have an emotionally and physiologically integrated manner of processing infant distress sounds, whereas in insecure adoptees experiential arousal and physiological arousal are dissociated, with a combination of lower perceived urgency but heightened sympathetic reactivity when listening to repeated bouts of cry sounds. The deactivating style of emotional reactivity displayed by the insecure individuals in reaction to the attachment-related stressor might have clinical implications. Associations with harsh discipline found in a previous study [38] already suggested that heightened sympathetic arousal in response to infant crying could be an important factor explaining problematic caregiving [45]. Our findings suggest that transmission to the next generation of problematic caregiving originating from insecure attachments [60] might be ingrained at the level of physiological functioning.

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